

Bridges Design Diploma

By EngoSoft training center

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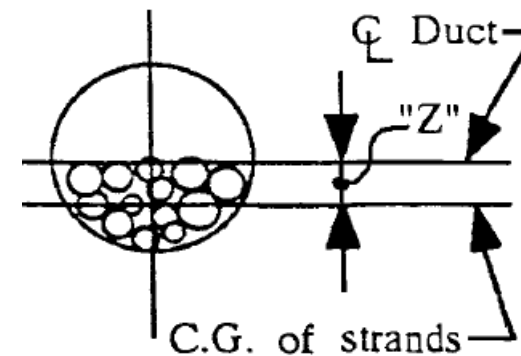
Allowable stress in prestressed concrete

Allowable stress in prestressed concrete

Strands location with respect to duct C.L (C5.9.1.6)

- Vertically draped strand tendons should be assumed to be at the bottom of the duct in negative moment areas and at the top of the duct in positive moment areas.
- The location of the tendon center of gravity, with respect to the centerline of the duct, is shown for negative moment in Figure

Duct Size (mm)	Z (mm)
≤ 75 OD	12
>75 OD to 100	20
over 100	25



Allowable stress in prestressed concrete



Stress Limitations for Prestressing Tendons (cl. 5.9.3)

- The tendon stress due to prestress or at the service limit state shall not exceed the values:

- Specified in Table 5.9.3-1, or.
- Recommended by the manufacturer of the tendons or anchorages.
- For post-tensioning, the short-term allowable of $0.90f_{py}$ may be allowed for short periods of time prior to seating to offset seating and friction losses, provided that the other values in Table 5.9.3-1 are not exceeded.

Condition	Tendon Type		
	Stress-Relieved Strand and Plain High-Strength Bars	Low Relaxation Strand	Deformed High-Strength Bars
Pretensioning			
Immediately prior to transfer (f_{pbt})	$0.70f_{pu}$	$0.75f_{pu}$	—
At service limit state after all losses (f_{pe})	$0.80f_{py}$	$0.80f_{py}$	$0.80f_{py}$
Post-Tensioning			
Prior to seating—short-term f_{pbt} may be allowed	$0.90f_{py}$	$0.90f_{py}$	$0.90f_{py}$
At anchorages and couplers immediately after anchor set	$0.70f_{pu}$	$0.70f_{pu}$	$0.70f_{pu}$
Elsewhere along length of member away from anchorages and couplers immediately after anchor set	$0.70f_{pu}$	$0.74f_{pu}$	$0.70f_{pu}$
At service limit state after losses (f_{pe})	$0.80f_{py}$	$0.80f_{py}$	$0.80f_{py}$

Allowable stress in prestressed concrete

Stress Limits for Concrete (cl. 5.9.4)

- For Temporary Stresses before Losses—Fully Prestressed Components:
 - Compression Stresses:
 - The compressive stress limit for pretensioned and post-tensioned concrete components, including segmentally constructed bridges, shall be $0.60 f'_{ci}$ (Mpa)

Allowable stress in prestressed concrete

Stress Limits for Concrete (cl. 5.9.4)

- For Temporary Stresses before Losses—Fully Prestressed Components:
 - Tension Stresses:
 - The limits in Table 5.9.4.1.2-1 shall apply for tensile stresses.

Bridge Type	Location	Stress Limit
Other Than Segmentally Constructed Bridges	In precompressed tensile zone without bonded reinforcement	N/A
	In areas other than the precompressed tensile zone and without bonded reinforcement	$0.25\sqrt{f'_{ci}} \leq 1.38 \text{ (MPa)}$
	In areas with bonded reinforcement (reinforcing bars or prestressing steel) sufficient to resist the tensile force in the concrete computed assuming an uncracked section, where reinforcement is proportioned using a stress of $0.5 f_y$, not to exceed 210 MPa.	$0.63\sqrt{f'_{ci}} \text{ (MPa)}$
	For handling stresses in prestressed piles	$0.415\sqrt{f'_{ci}} \text{ (MPa)}$

Allowable stress in prestressed concrete

Stress Limits for Concrete (cl. 5.9.4)

- For Stresses at Service Limit State after Losses—Fully Prestressed Components
 - Compression Stresses:
 - Compression shall be investigated using the Service Limit State Load Combination I.
 - The limits in Table 5.9.4.2.1-1 shall apply.

Location	Stress Limit
• In other than segmentally constructed bridges due to the sum of effective prestress and permanent loads	$0.45 f'_c$ (MPa)
• In segmentally constructed bridges due to the sum of effective prestress and permanent loads	$0.45 f'_c$ (MPa)
• In other than segmentally constructed bridges due to live load and one-half the sum of effective prestress and permanent loads	$0.40 f'_c$ (MPa)
• Due to the sum of effective prestress, permanent loads, and transient loads and during shipping and handling	$0.60 \phi_w f'_c$ (MPa)

Allowable stress in prestressed concrete

Stress Limits for Concrete (cl. 5.9.4)

- **For Stresses at Service Limit State after Losses—Fully Prestressed Components**
- The wall slenderness ratio of a hollow rectangular cross-section shall be taken as:

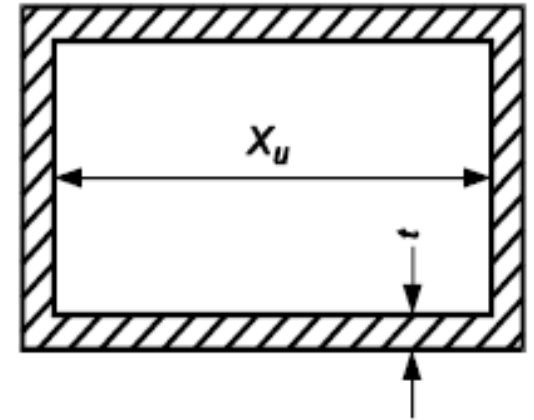
$$\lambda_w = \frac{X_u}{t}$$

where:

X_u = the clear length of the constant thickness portion of a wall between other walls or fillets between walls (mm)

t = thickness of wall (mm)

λ_w = wall slenderness ratio for hollow columns



Typical Monolithic Pier Section

Allowable stress in prestressed concrete

Stress Limits for Concrete (cl. 5.9.4)

- **For Stresses at Service Limit State after Losses—Fully Prestressed Components**
 - The wall slenderness ratio of a hollow rectangular cross-section shall be taken as:

$$\lambda_w = \frac{X_u}{t}$$

- If $\lambda_w \leq 15$, then $\phi_w = 1.0$ (5.7.4.7.2c-1)
- If $15 < \lambda_w \leq 25$, then $\phi_w = 1 - 0.025(\lambda_w - 15)$
(5.7.4.7.2c-2)
- If $25 < \lambda_w \leq 35$, then $\phi_w = 0.75$
(5.7.4.7.2c-3)

Allowable stress in prestressed concrete

Stress Limits for Concrete (cl. 5.9.4)

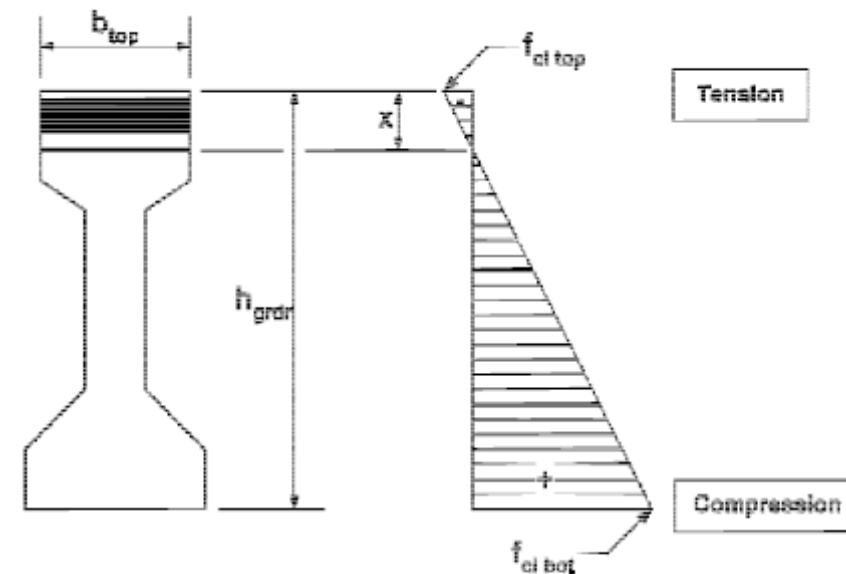
- For Stresses at Service Limit State after Losses—Fully Prestressed Components
 - Tension Stresses:
 - For longitudinal service load combinations that involve traffic loading tension stresses in members with bonded or unbounded prestressing tendons should be investigated using load combination Service III

Bridge Type	Location	Stress Limit
Other Than Segmentally Constructed Bridges	Tension in the Precompressed Tensile Zone Bridges, Assuming Uncracked Sections	
	For components with bonded prestressing tendons or reinforcement that are subjected to not worse than moderate corrosion conditions	$0.50\sqrt{f'_c}$ (MPa)
	- For components with bonded prestressing tendons or reinforcement that are subjected to severe corrosive conditions - For components with unbonded prestressing tendons	$0.25\sqrt{f'_c}$ (MPa) No tension

Allowable stress in prestressed concrete

Stress Limits for Concrete (cl. 5.9.4)

- **Non-prestressed reinforcement in tension zones**
 - Where bonded reinforcement is provided to allow use of the increased tensile limiting stress in areas with bonded reinforcement, the tensile force must be computed.
 - The tensile force is computed as the product of the average tensile stress and the computed area, as illustrated.
 - The required area of reinforcement, A_s , is computed by dividing the tensile force by the permitted stress in the reinforcement.



$$T = \frac{f_{ci \text{ top}}}{2} b_{top} x$$

$$A_s = \frac{T}{f_s}$$

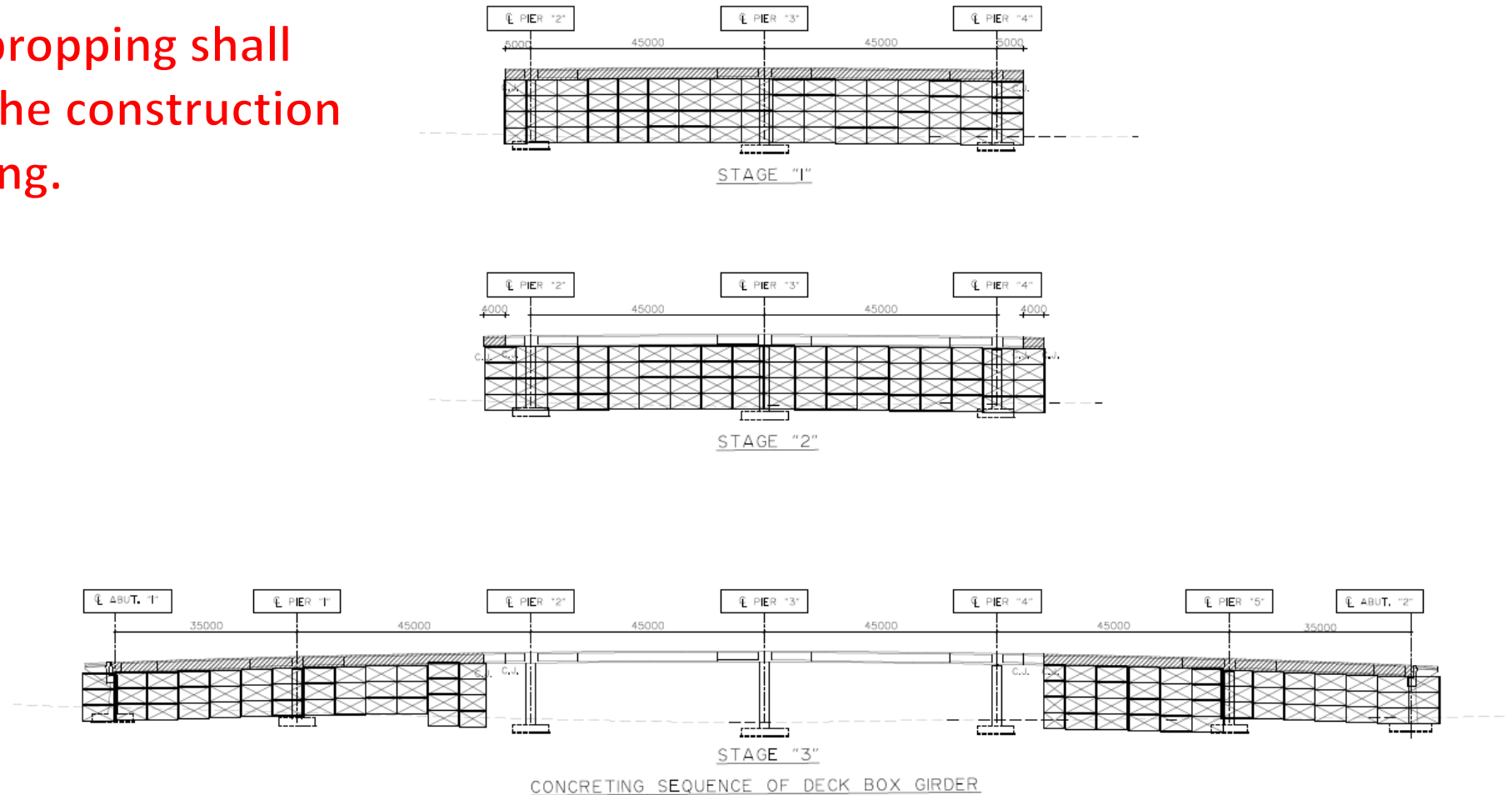
$$\text{where } f_s = 0.5 f_y \leq 206 \text{ MPa}$$

Prestressing Profile & Details

Prestressing Profile & Details

Staged Construction Drawing

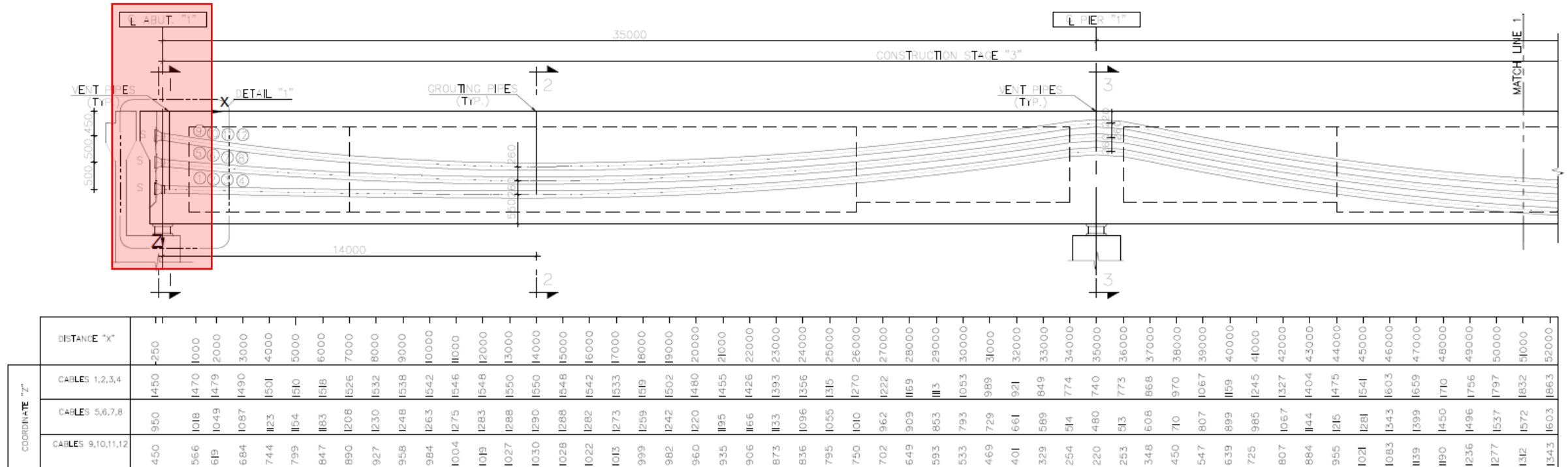
- Falsework and propping shall be provided in the construction sequence drawing.



Prestressing Profile & Details

Prestressing Profile (Elevation)

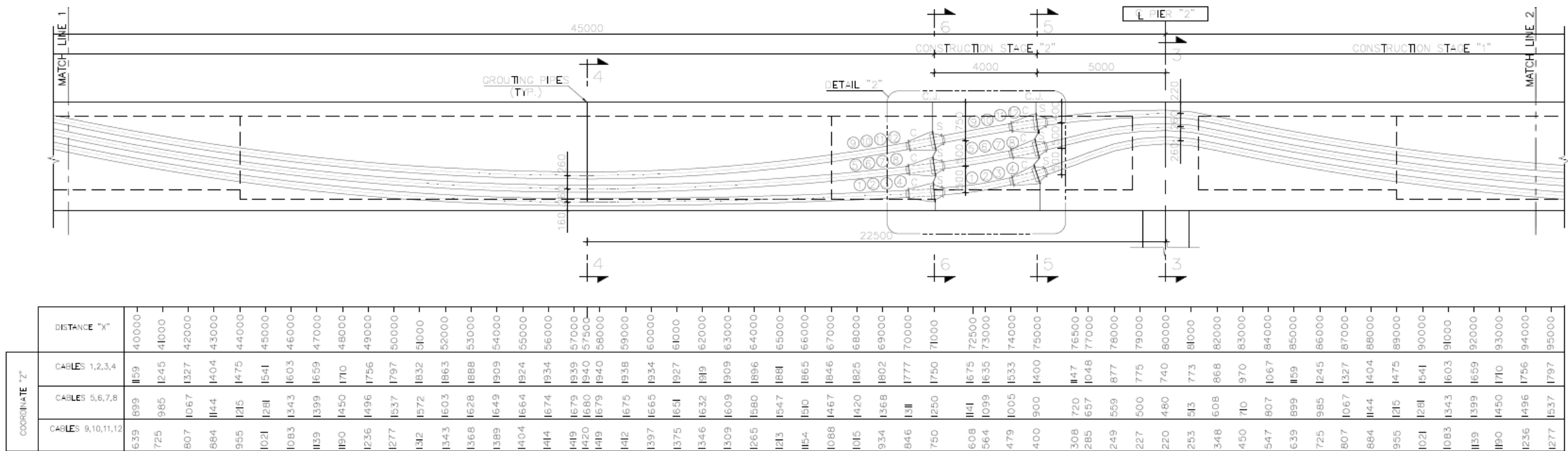
- Prestressing profile at each station for each tendons shall be provided.
- Coordinate system and origin shall be clearly defined and shown.



Prestressing Profile & Details

Prestressing Profile (Elevation)

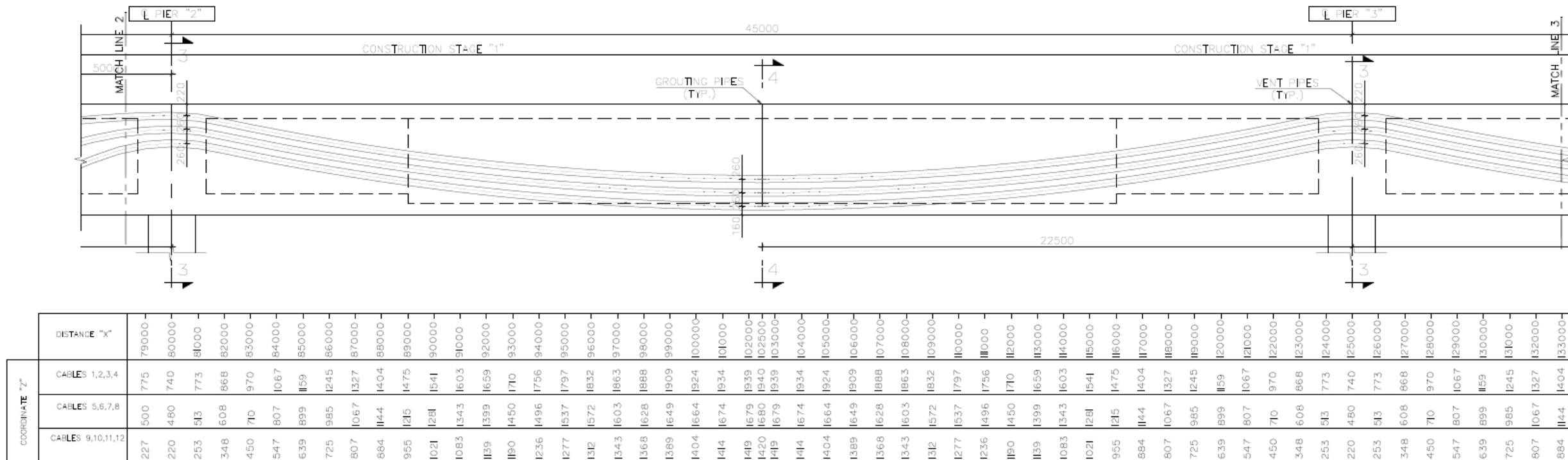
- Prestressing profile at each station for each tendons shall be provided.



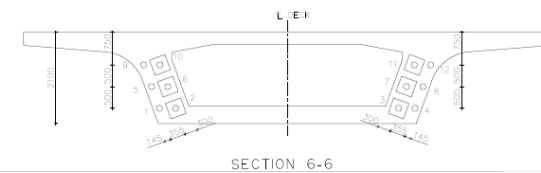
Prestressing Profile & Details

Prestressing Profile (Elevation)

- Prestressing profile at each station for each tendons shall be provided.



- Prestressing section at each change and controlling points positions shall be provided.
- Each tendon get a number for easy reference



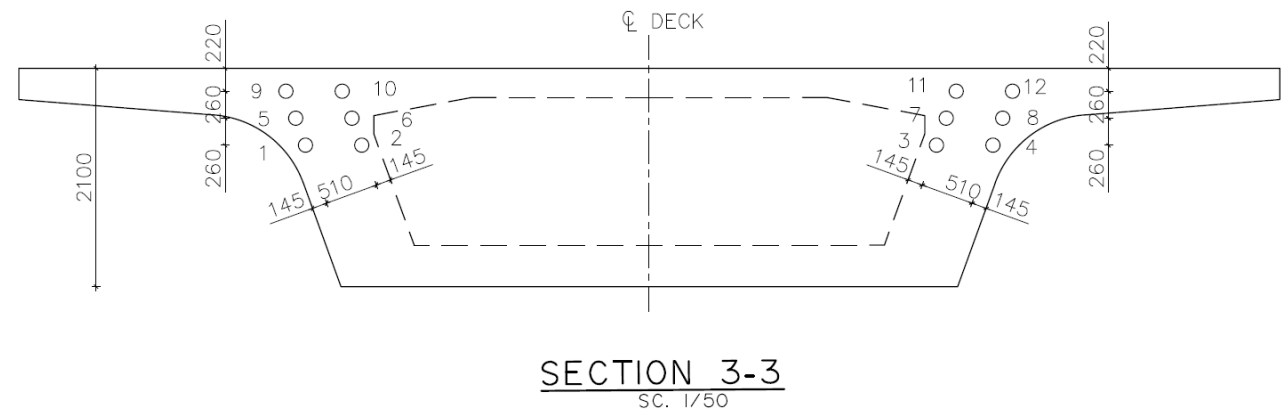
Prestressing Profile & Details

Prestressing Jacking Sequence

- Prestressing Shall be jacked one by one following a sequence that ensure symmetrical and balanced force over the bridge deck section

ALL CABLES SHALL BE STRESSED IN PAIRS ONE CABLE FROM EACH WEB SIMULTANEOUSLY AS PER THE BELOW TABLE.

STAGE No.	STRESSING PAIRS No.
1	(5 , 8) – (9 , 12) – (1 , 4)
2	(6 , 7) – (10 , 11) – (2 , 3)
3	(5 , 8) – (9 , 12) – (1 , 4) – (6 , 7) – (10 , 11) – (2 , 3)

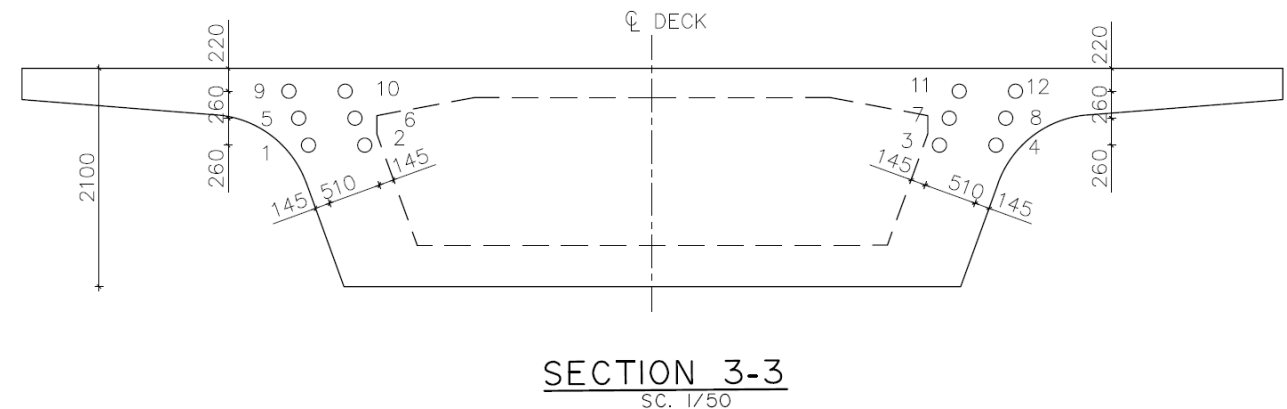


Prestressing Profile & Details

Prestressing Force per each Tendon

- Prestressing Shall be jacked one by one following a sequence that ensure symmetrical and balanced force over the bridge deck section

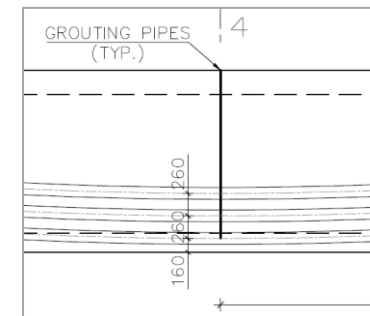
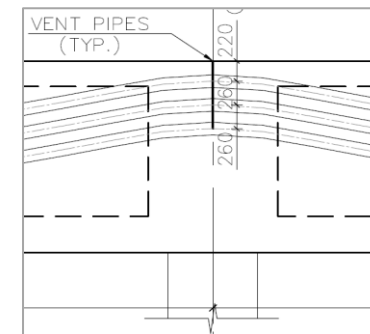
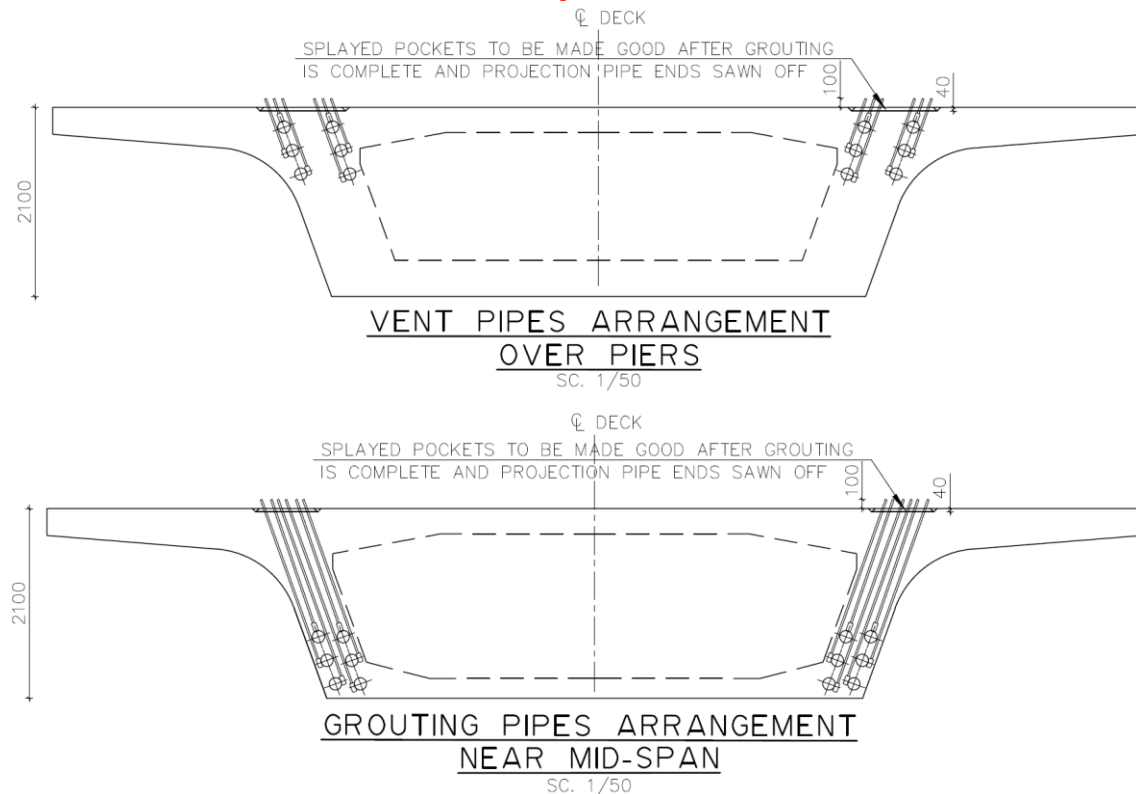
STAGE No.	CABLE No.	No. OF CABLES PER DECK	JACKING FORCE PER CABLE (KN)
1	1,4,5, 8,9,12	6X29 STRANDS	5292.21 KN
2	2,3,6, 7,10,11	6X29 STRANDS	5292.21 KN
3	1 TO 12	12X29 STRANDS	5292.21 KN



Prestressing Profile & Details

Prestressing Vent Pipes Locations

- Grouting vents are placed to be attached the lowest points of the tendons,
- While air vents are placed to be attached to the highest points of the tendons.



1745 940

1500
STRAIGHT

T.P. T.P.

154

① ⑤ ⑨

543

154

② ⑥ ⑩

R=8500 R=8500

277 154

154

50 293 532 372

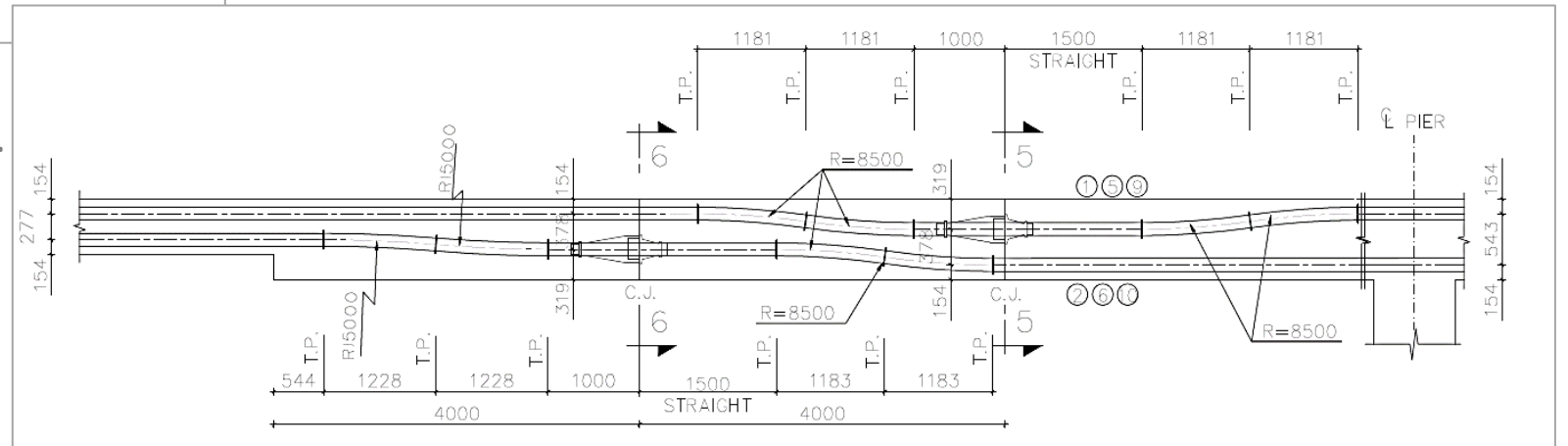
250

1000

902 T.P. 1111 T.P. 1498 T.P. 1498 T.P.

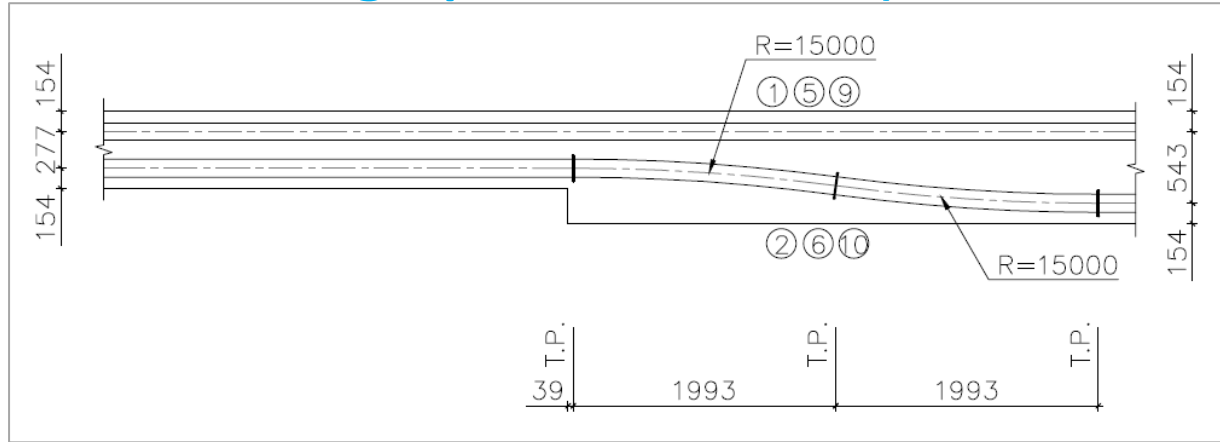
ANCHORAGE POCKET TO BE MADE WITH
NON-SHRINK CONCRETE 50/20 AFTER
STRESSING AND GROUTING OF TENDONS

Typical section plan in web at construction Joints
to secure sufficient anchorage HZ spacing.

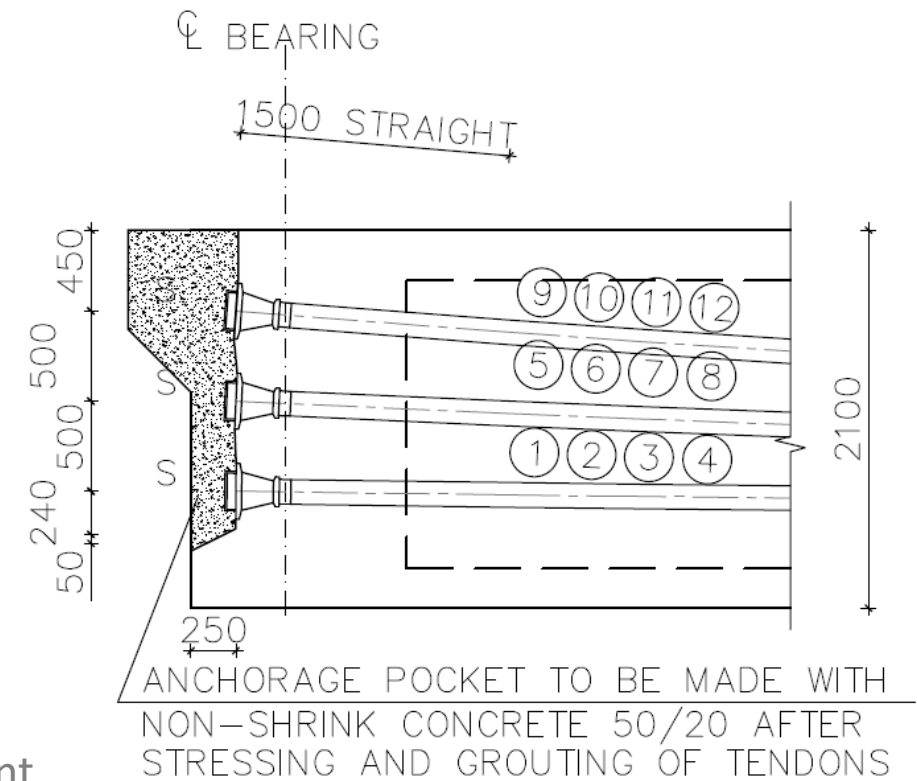


Prestressing Profile & Details

Prestressing Special Details (HZ maneuvering)



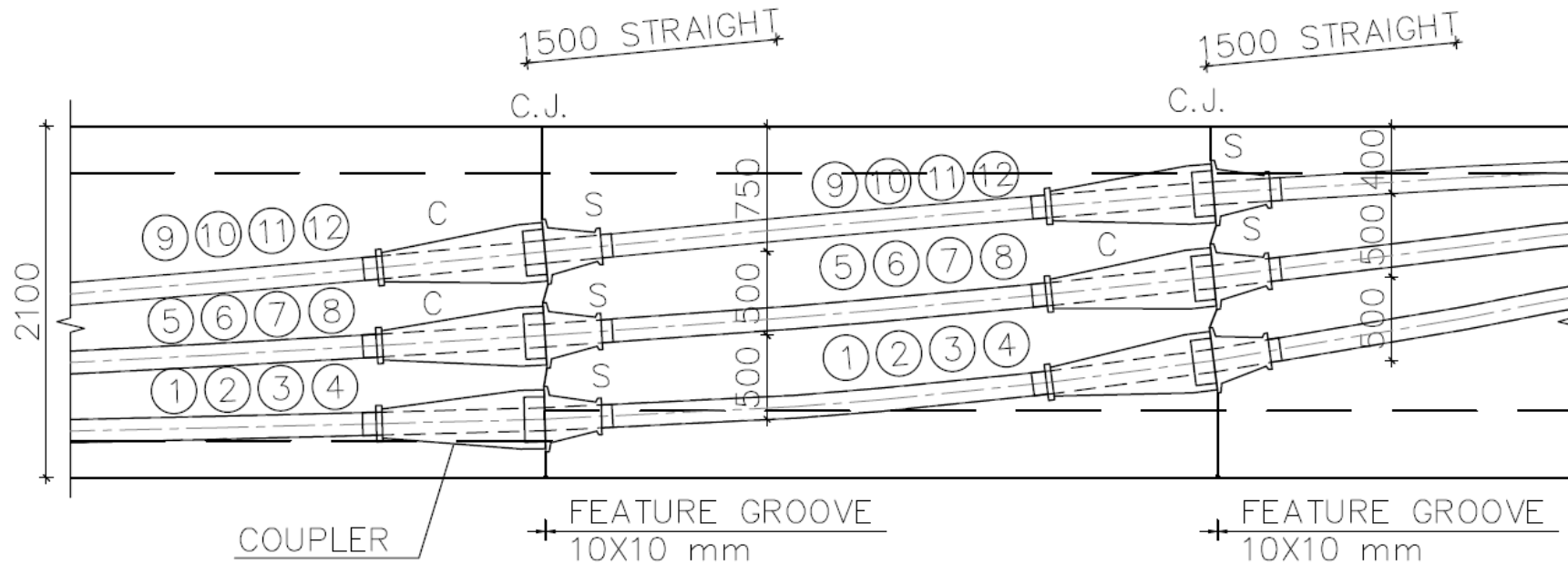
Typical section plan in web at web thickening (optional)



Typical detail elevation showing the pocket of prestressing at abutment

Prestressing Profile & Details

Prestressing Special Details (HZ maneuvering)



Typical detail elevation showing the construction joints